

81289-284781.ST25.txt
SEQUENCE LISTING

<110> Hovanec, Timothy A
<120> Method for Detecting Ammonia-Oxidizing Bacteria
<130> 81289-284781
<150> US 09/573,684
<151> 2000-05-19
<150> US 60/386,217
<151> 2002-09-19
<150> US 60/386,218
<151> 2002-09-19
<150> US 60/386,219
<151> 2002-09-19
<160> 23
<170> PatentIn version 3.2
<210> 1
<211> 1457
<212> DNA
<213> AOB Type A R7clone140 16S rDNA (SEQ ID NO:1)
<400> 1
attgaacgct ggcggcatgc ttacacatg caagtcgaac ggcagcacgg atgcttgcat 60
ctgtgtggcga gtggcggacg ggtgagtaat gcatcggaac gtatccagaa gaggggggta 120
acgcatcgaa agatgtgcta ataccgcata tactctaagg aggaagcag gggatcgaaa 180
gaccttgcg ttttgagcg gccgatgtct gattagctag ttggtggggt aaaggcctac 240
caaggcgacg atcagtagtt ggtctgagag gacgaccagc cacttgga ctgagacacg 300
gcccagactc ctacgggagg cagcagtggg gaattttgga caatggcgcg aagcctgatc 360
cagcaatgcc gcgtgagtga agaaggcctt cgggttgtaa agctctttca gtcgagaaga 420
aaaggttacg gtaataatc gtgactcatg acggtatcga cagaagaagc accggctaac 480
tacgtgccag cagccgcggt aatacgtagg gtgcaagcgt taatcggaat tactgggcgt 540
aaagggtgcg caggcgctt tgtaagtcag atgtgaaac cccgggctta acctgggaat 600
tgcgtttgaa actacaaggc tagagtgtgg cagagggagg tggaaattcca tgtgtagcag 660
tgaaatgcgt agagatatgg aagaacatcg atggcgaagg cagcctctg ggttaacact 720
gacgctcatg cagcaaagcg tggggagcaa acaggattag ataccctggt agtcacagcc 780
ctaaacgatg tcaactagtt gttgggcctt attaggcttg gtaacgaagc taacgcgtga 840
agttgaccgc ctggggagta cggtcgcaag attaaaactc aaaggaattg acggggacc 900
gcacaagcgg tggattatgt ggattaattc gatgcaacgc gaaaacactt acctaccctt 960
gacatgtagc gaattttcta gagatagatt agtgcttcgg gaacgctaac acagggtgctg 1020

81289-284781.ST25.txt

catggctgtc gtcagctcgt gtcgtgagat gttgggttaa gtcccgaac gagcgcaacc	1080
cttgtcatta attgccatca tttggttggg cactttaatg agactgccgg tgacaaaccg	1140
gaggaagggt gggatgacgt caagtcctca tggcccttat gggtagggct tcacacgtaa	1200
tacaatggcg cgtacagagg gttgccaaac cgcgaggggg agctaattctc agaaagcgcg	1260
tcgtagtcgg gatcggagtc tgcaactcga ctccgtgaag tcggaatcgc tagtaatcgc	1320
ggatcagcat gtcgcgggtga atacgttccc gggctctgta cacaccgcc gtcacaccat	1380
gggagtgggt ttaccagaa gcaggtagtc taaccgtaag gagggcgctt gccacggtga	1440
gattcatgac tgggggtg	1457

<210> 2
 <211> 1457
 <212> DNA
 <213> AOB Type A1 R7clone187 16S rDNA (SEQ ID NO:2)

<400> 2	
attgaacgat ggcggcatgc ttacacatg caagtgaac ggcagcacgg atgttgcgat	60
ctggtggcga gtggcggacg ggtgagtaat gcatcggaac gtatccagaa gaggggggta	120
acgcatcgaa agatgtgcta ataccgcata tactctaagg aggaagcag gggatcgaaa	180
gaccttcgcg ttttgagcgc gccgatgtct gattagctag ttggtgggggt aaagcgctac	240
caaggcgacg atcagtagtt ggtctgagag gacgaccagc cacactggga ctgagacagc	300
gcccagactc ctacgggagg cagcagtggg gaattttgga caatggcgcg aagcctgac	360
cagcaatgcc gcgtgagtga agaaggcctt cgggttgtaa agctctttca gtcgagaaga	420
aaagggttacg gtaataatc gtgacccatg acggtatcga cagaagaagc accggctaac	480
tacgtgccag cagccgcggt aatacgtagg gtgcaagcgt taatcggaat tactggcgct	540
aaagggtgcg caggcggcct tgtaagtcag atgtgaaatc cccgggctta acctgggaat	600
tgcttttgaa actacaaagc tagagtgtgg cagagggagg tggaaattcca tgtgtagcag	660
tgaatgcgt agagatatgg aagaacatcg atggcgaagg cagcctcctg ggttaacact	720
gacgctcatg cacgaaagcg tggggagcaa acaggattag ataccctggt agtccacgcc	780
ctaaacgatg tcaactagtt gttgggcctt attaggcttg gtaacgaagc taacgcgtga	840
agttgaccgc ctggggagta cggtcgcaag attaaaactc aaaggaattg acggggaccc	900
gcacaagcgg tggattatgt ggattaattc gatgcaacgc gaaaaacctt acctaccctt	960
gacatgtagc gaattttcta gagatagatt agtgcttcgg gaacgctaac acagggtgctg	1020
catggctgtc gtcagctcgt gtcgtgagat gttgggttaa gtcccgaac gagcgcaacc	1080
cttgtcatta attgccatca tttggttggg cactttaatg agactgccgg tgacaaaccg	1140
gaggaagggt gggatgacgt caagtcctca tggcccttat gggtagggct tcacacgtaa	1200

81289-284781.ST25.txt

tacaatggcg cgtacagagg gttgccaacc cgcgaggggg agctaattctc agaaagcgcg	1260
tcgtagtcgc gatcggagtc tgcaactcga ctccgtgaag tcggaatcgc tagtaatcgc	1320
ggatcagcat gtcgcggtga atacgttccc gggctttgta cacaccgccc gtcacaccat	1380
gggagtgggt ttaccacaga gcaggtagtc taaccgtaag gagggcgctt gccacggtga	1440
gattcatgac tgggggt	1457

<210> 3
 <211> 1458
 <212> DNA
 <213> AOB Type B R3clone5 16S rDNA (SEQ ID NO:3)

<400> 3	
attgaacgct ggcggcatgc ttacacatg caagtcgaac ggcagcacgg gggcaaccct	60
ggtggcgagt ggcgaacggg tgagttaatac atcggaacgt atcttcgagg gggggataac	120
gcaccgaag gtgtgctaata accgcataat ctccacggag aaaagcaggg gatcgcaaga	180
ccttgcgctc ttggagcggc cgatgtctga ttagttagtt ggtgaggtaa tggcttacca	240
aggcgacagt cagtactggt tctgagagga cgaccagcca cactgggact gagacacggc	300
ccagactcct acgggaggca gcagtgggga attttggaca atgggggaaa ccctgatcca	360
gcatatgccc gtgagtgaag aaggccttcg ggttgtaag ctctttcagc cggaacgaaa	420
cgggtcacggc taatacccggt gactactgac ggtaccggaa gaagaagcac cggctaacta	480
cgtgccagca gccgcggtaa tacgtagggt gcaagcgtaa atcggaatta ctgggcgtaa	540
agcgtgcgca ggcgggtttt taagtcagat gtgaaagccc cgggcttaac ctgggaactg	600
cgtttgaaac tacaaggcta gagtggtgga gaggggggtg gaattccacg tgtagcagtg	660
aaatgcgtag agatgtggag gaacaccgat ggcgaaggca gccccctggg ttaacaccga	720
cgctcaggca cgaagcgctg gggagcaaac aggattagat accctggtag tccacgccct	780
aaacgatgtc aactagtgtt cgggtcttaa cggacttggt aacgcagcta acgctggaag	840
ttggccgcct ggggagtacg gtcgcaagat taaactcaa aggaattgac ggggaccgc	900
acaagcgggt gattatgtgg attaattcga tgcaacgcga aaaaccttac ctaccttgga	960
catgtaccga agcccgcga gaggtgggtg tgcccgaag ggagcggtaa cacaggtgct	1020
gcatggctgt cgtcagctcg gtgcgtgaga tgttgggtta agtcccgaac cgagcgcaac	1080
ccttgtcatt aattgccatc attcagttgg gcactttaat gaaactgccg gtgacaaacc	1140
ggaggaaggt ggggatgacg tcaagtcctc atggccctta tgggtagggc ttacacgta	1200
atacaatggc gcgtacagag ggttgccaac ccgcgagggg gagctaattc cagaagcgc	1260
gtcgtagtcc ggatcgaggt ctgcaactcg actcgtgaa gtcggaatcg ctagttaacg	1320
cggatcagca tgtcgcgggt aatacgttcc cgggtcttgt acacaccgcc cgtcacacca	1380

81289-284781.ST25.txt

tgaggagtggg ttccaccaga agcaggtagt ctaaccgcaa ggagggcgct tgccacgggtg 1440
 agattcatga ctgggggtg 1458

<210> 4
 <211> 1460
 <212> DNA
 <213> AOB Type C R5clone47 16S rDNA (SEQ ID NO:4)

<400> 4
 attgaacgct ggcggcatgc ttacacatg caagtcgaac ggcagcgggg gcttcggcct 60
 gccggcgagt ggcgaacggg tgagtaatac atcggaacgt gtccttaagt ggggaataac 120
 gcatcgaag atgtgctaata accgcatatc tctgaggaga aaagcagggg atcgcaagac 180
 cttgcgctaa aggagcggcc gatgtctgat tagctagtgt gtggggtaaa ggcttaccaa 240
 ggcacgatc agtagttggt ctgagaggac gaccaaccac actgggactg agacacggcc 300
 cagactccta cgggaggcag cagtggggaa ttttgacaa tgggcgaaag cctgattccag 360
 ccattgccg tgagtgaaga aggccttcgg gttgtagagc tcttttagtc agaaagaaag 420
 aatcatgatg aataattatg atttatgacg gtagtcagac aaaaagcacc ggctaactac 480
 gtgcagcag cgcgggtaat acgtagggtg cgagcggttaa tcggaattac tgggcgtaaa 540
 ggggtgcgag cgggttttgt aagtcagatg tgaagcccc gggcttaacc tgggaattgc 600
 gtttgaaact acaaggctag agtgcagcag aggggagtggt aattccatgt gtagcagtga 660
 aatgcgtaga gatgtggaag aacaccgatg gcgaaggcag ctccctgggt tgacactgac 720
 gctcatgcac gaaagcgtgg ggagcaaca ggattagata ccctggtagt ccacgcccta 780
 aacgatgtca actggttgct ggaatctaatt aaggatttgg taacgtagct aacgcgtgaa 840
 gttgaccgcc tggggagtac ggtcgaaga ttaaaactca aaggaattga cggggaccgg 900
 cacaagcggg ggatttatgt gattaattcg atgcaacgcg aaaaacctta cctacccttg 960
 acatgcttgg aatctagtgg agacataaga gtgcccga aa gggagccaag acacaggtgc 1020
 tgcattgctg tcgtcagctc gtgtcgtgag atgttggggt aagtcgccca acgagcgcaa 1080
 ccctgtcac taattgctat cattctaat gaggacttta gtgagactgc cgtgacaaa 1140
 ccggaggaa gttgggatga cgtcaagtcc tcattggcct tatgggtagg gcttcacacg 1200
 taatacaatg cgtgtgacag aggggttgcca acccgcgagg gggagccaat ctgacaaagc 1260
 acgtcgtagt ccggatcga ggtcgaact cgactccgtg aagtcggaat cgtagtaaat 1320
 cgcgatcag catgcccggt tgaatacgtt cccgggtctt gtacacaccg cccgtcacac 1380
 catgggagt gttttcacca gaagcaggta gtttaaccgt aaggaggagc cttgccacgg 1440
 tgggggtcat gactgggggtg 1460

```

<210> 5
<211> 18
<212> DNA
<213> Oligonucleotide Probe (SEQ ID NO:5)

<400> 5
ccccctctt ctggatac 18

<210> 6
<211> 18
<212> DNA
<213> PCR primer (SEQ ID NO:6)

<400> 6
cggaacgtat ccagaaga 18

<210> 7
<211> 18
<212> DNA
<213> PCR primer (SEQ ID NO:7)

<400> 7
atctctagaa aattcgct 18

<210> 8
<211> 19
<212> DNA
<213> Oligonucleotide probe (SEQ ID NO:8)

<400> 8
tccccactc gaagatacg 19

<210> 9
<211> 17
<212> DNA
<213> PCR primer (SEQ ID NO:9)

<400> 9
atcggaacgt atcttcg 17

<210> 10
<211> 16
<212> DNA
<213> PCR primer (SEQ ID NO:10)

<400> 10
ccacctctcr gcgggc 16

<210> 11
<211> 19
<212> DNA
<213> PCR primer (SEQ ID NO:11)

<400> 11
tcagaaagaa agaatcatg 19

```

```

<210> 12
<211> 19
<212> DNA
<213> PCR primer (SEQ ID NO:12)

<400> 12
gtctccayta gattccaag 19

<210> 13
<211> 17
<212> DNA
<213> PCR primer (SEQ ID NO:13)

<400> 13
gtttgatcct ggctcag 17

<210> 14
<211> 19
<212> DNA
<213> PCR primer (SEQ ID NO:14)

<400> 14
ggttaccttg ttacgactt 19

<210> 15
<211> 17
<212> DNA
<213> PCR primer (SEQ ID NO:15)

<400> 15
cctacgggag gcagcag 17

<210> 16
<211> 18
<212> DNA
<213> PCR primer (SEQ ID NO:16)

<400> 16
gwattaccgc ggckgctg 18

<210> 17
<211> 20
<212> DNA
<213> PCR primer (SEQ ID NO:17)

<400> 17
cactctagcy ttgtagtttc 20

<210> 18
<211> 1467
<212> DNA
<213> N. Aestuarii-like AOB P4clone42 16S rDNA (SEQ ID NO:18)

<400> 18
ttgatcatgg ctcagattga acgctggcgg catgctttac acatgcaagt cgaacggcag 60
cacgggtgct tgcacctggt ggcgagtggc ggacgggtga gtaatgcac ggaacgtgtc 120

```

81289-284781.ST25.txt

cagaagtggg	ggataacgca	tcgaaagatg	tgctaatacc	gcatattctc	tacggaggaa	180
agcaggggat	cgaaagacct	tgtgctttt	gagcggccga	tgcttgatta	gctagtgtgt	240
ggggtaaaag	cctaccaagg	caacgatcag	tagttggtct	gagaggacga	ccagccacac	300
tgggactgag	acacggccca	gactcctacg	ggaggcgagc	gtggggaatt	ttggacaatg	360
ggcgaaagcc	tgatccagca	atgccgctg	agtgaagaag	gcttcgggtt	gtaaagctct	420
ttcagtcgag	aagaaaaggt	tgtgactaat	aatcacaact	tatgatggta	ccgacagaag	480
aagcaccggc	taactacgtg	ccagcagccg	cggtaatacg	taggggtcaa	gcgttaatcg	540
gaattactgg	gcgtaaaagg	tgcgcaggcg	gctttgtaag	tcagatgtga	aatccccggg	600
cttaacctgg	gaattgcgtt	tgaactaca	aagctagagt	gtagcagagg	gggggtggaat	660
tccatgtgta	gcagtgaaat	gcgtagagat	atggaagaac	atcgatggcg	aaggcagccc	720
cctgggttaa	cactgacgct	catgcacgaa	agcgtgggga	gcaaacagga	ttagataccc	780
tggtagtcca	cgccctaacc	gatgtcaact	agttgttggt	ccttactagg	cttggtaacg	840
tagctaaccg	gtgaagtgtg	ccgcctgggg	agtacggtcg	caggattaaa	actcaaagga	900
attgacgggg	accgcacaa	gcggtggatt	atgtggtgta	attcgatgca	acgcgaaaaa	960
ccttacctac	ccttgacatg	tagcgaatat	tttagagata	aaatagtgcc	ttcgggaaacg	1020
ctaacacagg	tgctgcattg	ctgtcgtcag	ctcgtgtcgt	gagatgttgg	gttaagtccc	1080
gcaacgagcg	caacccttgt	cattaattgc	catcatttag	ttgggcactt	taatgagact	1140
gccggtgaca	aaccggagga	aggtggggat	gacgtcaagt	cctcatggcc	cttatgggta	1200
gggcttcaca	cgtaatacaa	tggcgcgtac	agaggggttg	caaccgcga	gggggagcta	1260
atctcagaaa	gcgcgtcgta	gtccggatcg	gagtctgcaa	ctcgactccg	tgaagtcgga	1320
atcgctagta	atcgcgatc	agcatgtcgc	ggtgaatacg	ttcccggttc	ttgtacacac	1380
cgcccgctac	accatgggag	tgggtttcac	cagaagcaga	tagtctaacc	gtaagagggc	1440
gtttgccacg	gcgagattca	tgactgg				1467

<210> 19
 <211> 1494
 <212> DNA
 <213> N. Aestuarii-like AOB P4clone31 16S rDNA (SEQ ID NO:19)

<400> 19						
agtttgatca	tggctcagat	tgaacgctgg	cggcatgctt	tacacatgca	agtcgaacgg	60
cagcacgggt	gcttgcacct	ggtggcgagt	ggcggacggg	tgagtaatgc	atcggaaactg	120
gtccggaagt	gggggataac	gcatcgaaag	atgtgcta	accgcatatt	ctctacggag	180
gaaagcaggg	gatcgaaaga	ccttgtgtct	ttggagcggc	cgatgcctga	ttagctagtt	240
ggtggggtaa	aggcctacca	aggcaacgat	cagtagttgg	tctgagagga	cgaccagcca	300

81289-284781.ST25.txt

cactgggact	gagacacggc	ccagactcct	acgggaggca	gcagtgggga	attttgga	360
acgggcgaaa	gcctgatcca	gcaatgccgc	gtgagtgaag	aaggccttcg	ggttgtaaa	420
ctctttcagt	cgagaagaaa	aggttgtagc	taataatcac	aacttatgac	ggtaccgaca	480
gaagaagcac	cggctaacta	cgtgccagca	gcccggttaa	tacgtagggt	gcaagcgtaa	540
atcggaatta	ctgggcgtaa	aggggtgcga	ggcggctttg	taagtcatgat	gtgaaatccc	600
cgggcttaac	ctgggaattg	cgtttgaaac	tacaaagcta	gagtgtagca	gaggggggtg	660
gaattccatg	tgtagcagtg	aaatgcgtag	agatatggaa	gaacatcgat	ggcgaaggca	720
gccccctggg	ttaacactga	cgtcatgca	cgaagcgtg	gggagcaaac	aggattagat	780
accctggtag	tcacgcacct	aaacgatgtc	aactagtgtt	tgggccttac	taggcttggt	840
aacgtagcta	acgcgtgaag	ttgaccgcct	ggggagtacg	gtcgcaagat	taaaactcaa	900
aggaattgac	ggggaccgcg	acaagcgggt	gattatgtgg	attaattcga	tgcacgcgca	960
aaaaccttac	ctacccttga	catgtagcga	atattttaga	gataaaatag	tgccttcggg	1020
aacgctaaca	cagggtgctg	atggctgtcg	tcagctcgtg	tcgtgagatg	tggggttaag	1080
tcccgcaacg	agcgcaaccc	ttgtcattaa	ttgccatcat	ttagttgggc	actttaatga	1140
gactgcgggt	gacaaaccgg	aggaaggtgg	ggatgacgtc	aagtccctcat	ggcccttatg	1200
ggtaggggctt	cacacgtaat	acaatggcgc	gtacagaggg	ttgccaaccc	gcgaggggga	1260
gctaattctca	gaaagcgcgt	cgtagtccgg	atcggaagta	gcaactcgac	tccgtgaagt	1320
cggaatcgct	agtaatcgcg	gatcagcatg	tcgcggtgaa	tacgttcccg	ggccttgtag	1380
acaccgcccg	tcacaccatg	gaagttggct	gcaccagaag	taggttgtct	aaccctcggg	1440
aggacgctta	ccacggtgtg	gtcaatgact	tggggtgaag	tcgtaacaag	gtaa	1494

<210> 20
 <211> 1491
 <212> DNA
 <213> N. Aestuarii-like AOB BF16clone57 16S rDNA (SEQ ID NO:20)

<400> 20						
gtttgatcat	ggctcagatt	gaacgctggc	ggcatgcttt	acacatgcaa	gtcgaacggc	60
agcacgggtg	cttgacctg	gtggcgagtg	cggacgggt	gagtaatgca	tcggaacgtg	120
tccagaagtg	ggggataacg	catcgaaaga	tgtgctaata	ccgcatattc	tctacggagg	180
aaagcagggg	atcgaaagac	cttgctgttt	tggagcgggc	gatgcctgat	tagctagtgt	240
gtgggggtaaa	ggcctaccaa	ggcaacgata	agtagttggt	ctgagaggac	gaccagccac	300
actgggactg	agacacggcc	cagactccta	cggagggcag	cagtggggaa	ttttggacaa	360
tgggcgaaa	cctgatccag	caatgccgcg	tgagtgaaga	aggccttcg	gttgtaaagc	420
tctttcagtc	gagaagaaaa	ggttgtgact	aataatcaca	acttatgacg	gtaccgacag	480

81289-284781.ST25.txt

```

aagaagcacc ggctaactac gtgccagcag ccgcggtaat acgtaggggtg caagcgtaa 540
tcggaattac tgggcgtaaa ggggtcgagc gcgcctttgt aagtcagatg tgaatcccc 600
gggcctaacc tgggaattgc gtttagaaact acaaagctag agtgtagcag aggggggtgg 660
aattccatgt gttagcagtg aatgcgtaga gatatggaag aacatcgatg gcgaaggcag 720
ccccctgggt taacactgac gctcatgcac gaaagcgtgg ggagcaaaca ggattagata 780
ccctggtagt ccacgcccta aacgatgtca actagtgtgt ggcccttact aggccttggt 840
acgtagctaa cgcgtgaagt tgaccgcctg gggagtagcg tcgcaagatt aaaactcaaa 900
ggaattgacg gggacccgca caagcgtggg attatgtgga ttaattcgat gcaacgcgaa 960
aaaccttacc tacccttgac atgtagcgaa tattttagag ataaaatagt gccttcggga 1020
acgcataacac aggtgctgca tggctgtcgt cagctcgtgt cgtgagatgt tgggttaagt 1080
cccgcacgca gcgcaacctt tgtcattaat tgccatcatt tagttgggca ctttaatgag 1140
actgccggtg acaaaccgga ggaagggtgg gatgacgtca agtcctcatg gcccttatgg 1200
gtagggtctt acacgtaata caatggcgcg tacagagggg tgccaacccg cgagggggag 1260
ctaattctag aaagcgcgtc gtatgccgga tcggagtctg caactcgact ccgtgaagtc 1320
ggaatcgcta gtaatcgcg atcagcatgt cgcggtgaat acgttcccgg gtcttgtaca 1380
caccgccccg cacaccatgg gagtgggttt caccagaagc agatagtcta accgtaagga 1440
gggcgtttgc cagcgtgaga ttcatgactg ggggtgaagtc gtaacaattt a 1491

```

```

<210> 21
<211> 18
<212> DNA
<213> oligonucleotide probe (SEQ ID NO:21)

```

```

<400> 21
tccccactt ctggacac 18

```

```

<210> 22
<211> 21
<212> DNA
<213> PCR primer (SEQ ID NO:22)

```

```

<400> 22
gtgactaata atcacaactt a 21

```

```

<210> 23
<211> 20
<212> DNA
<213> PCR primer (SEQ ID NO:23)

```

```

<400> 23
ttatctctaa aatattcgct 20

```